73rd MORSS CD Cover Page

UNCLASSIFIED DISCLOSURE FORM CD Presentation

712CD

For office use only 41205

21-23 June 2005, at US Military Academy, West Point, NY

Please complete this form 712CD as your cover page to your electronic briefing submission to the MORSS CD. Do not fax to the MORS office.

Author Request **(To be completed by applicant) - The following author(s) request authority to disclose the following presentation in the MORSS Final Report, for inclusion on the MORSS CD and/or posting on the MORS web site.**

Name of Principal Author and all other author(s):

John R. Tindle, Joyce Stivers, Danny L. Mellott

Principal Author's Organization and address:

Northrop Grumman IT – TASC
Lightning Solutions – West
1795 Jet Wing Drive Suite 200
Colorado Springs, CO 80916

Phone: (719) 622-5205
Fax: (719) 638-8296
Email: john.tindle@ngc.com

Original title on 712 A/B: ***The Analytical Process Used to Develop Military Utility-Based Architectures for the Air Force Space Command's Integrated Planning Process***

Revised title: N/A

Presented in (input and Bold one): (WG_**05**, CG___, Special Session ___, Poster, Demo, or Tutorial):

This presentation is believed to be:
UNCLASSIFIED AND APPROVED FOR PUBLIC RELEASE

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 2005	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The Analytical Process Used to Develop Military Utility-Based Architectures for the Air Force Space Commands Integrated Planning Process	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Northrop Grumman IT TASC Lightning Solutions West 1795 Jet Wing Drive Suite 200 Colorado Springs, CO 80916**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM201946, Military Operations Research Society Symposium (73rd) Held in West Point, NY on 21-23 June 2005. , The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**25**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

The Analytical Process Used to Develop Military Utility-Based Architectures for the Air Force Space Command's Integrated Planning Process

Mr Danny Mellott
Ms Joyce Stivers
Mr John Tindle

Agenda

- **AFSPC's Integrated Planning Process (IPP)**
- **Problem Description**
- **Revised Analytical Process**
- **Model Descriptions**
- **Model Integration**
- **Conclusion**

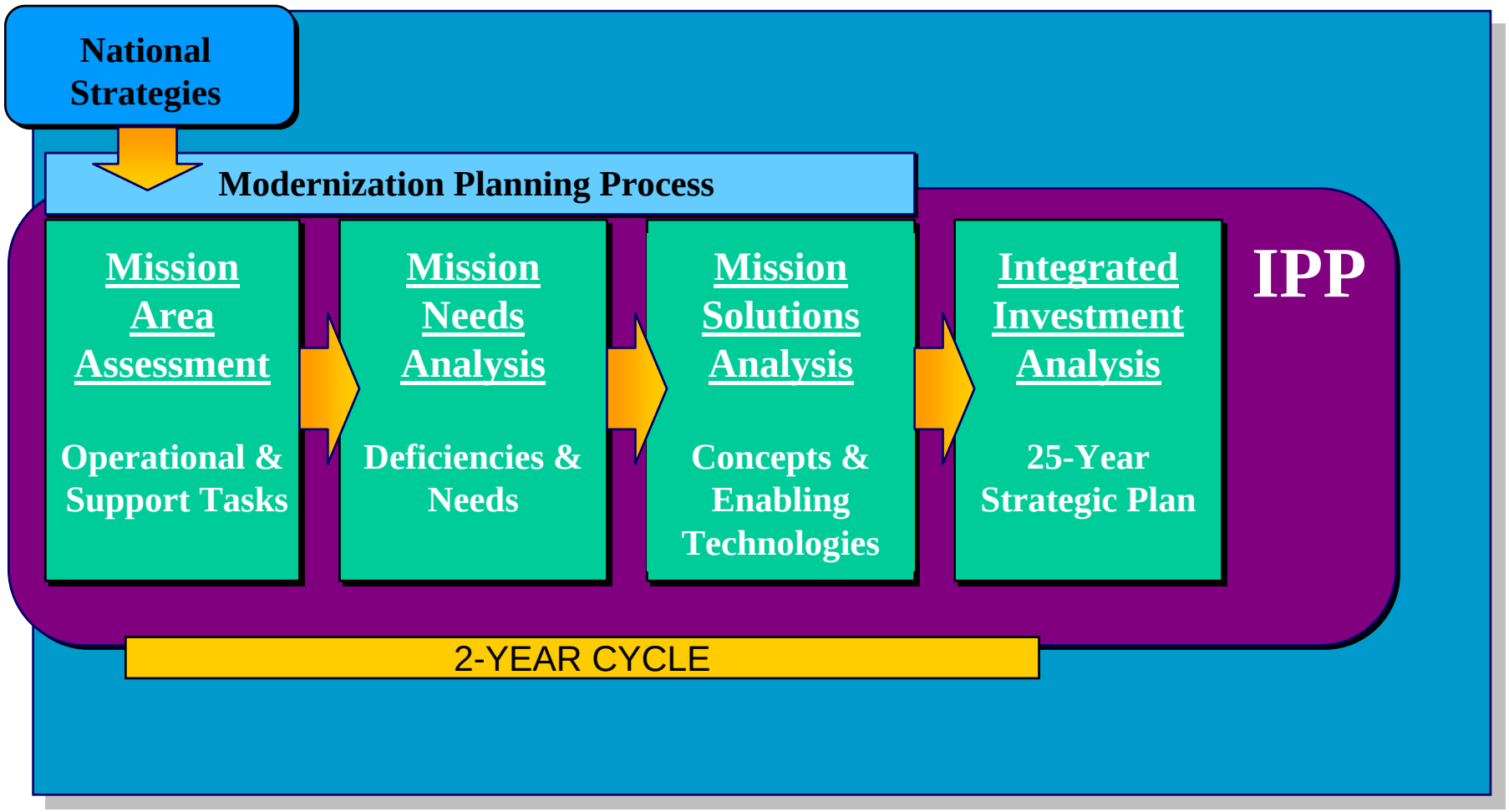
IPP Defined

- **An iterative process to evaluate and refine the objectives and tasks of assigned Air Force Mission Areas and functions**
- **Identifies deficiencies in mission and functional areas caused by changes in national military strategy, global political-military threats, and fiscal constraints**
- **The foundation for requirements generation and the acquisition process**
- **Conducted in four stages**
  - **Mission Area Assessment (MAA)**
  - **Mission Needs Analysis (MNA)**
  - **Mission Solutions Analysis (MSA)**
  - **Integrated Investment Analysis (IIA)**
- **Relies heavily on modeling and simulation (M&S) to evaluate operational support tasks that support a military strategy and objective**

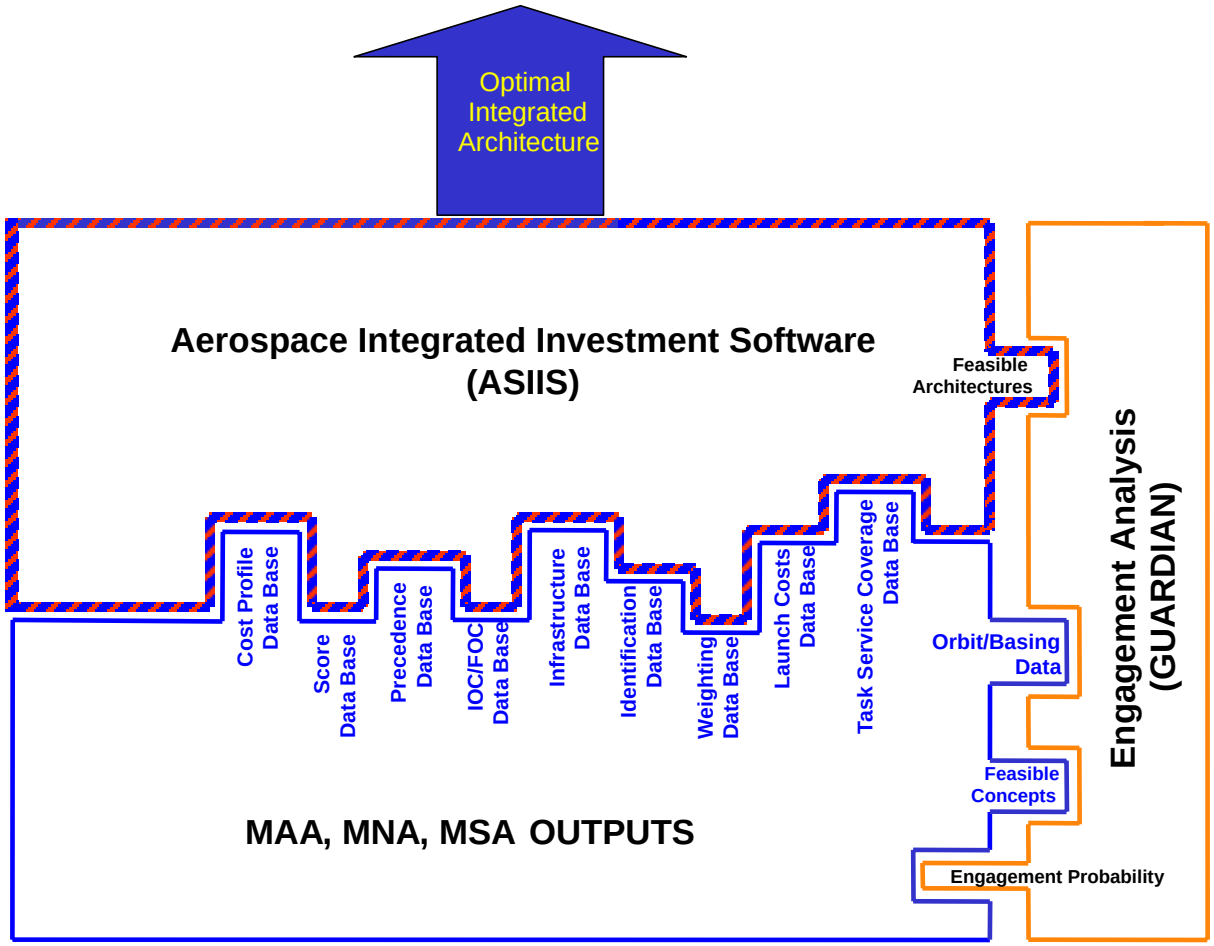
IPP Goals

- **PROVIDE MAXIMUM SUPPORT TO THE WAR FIGHTER**
  - **Identify the best architecture (family-of-systems) that will provide what the war fighter needs**
  - **Provide the guidance for changing doctrine, tactics, training, procedures, and investing dollars for force modernization to achieve the combat capability needed for the future**
- **INFLUENCE Program Objective Memorandum (POM) DECISIONS**
- **PROVIDE ANALYTICAL RIGOR to identify the best architecture for POM deliberations based on:**
  - **Minimize task coverage shortfall**
  - **Maximize total task coverage**
  - **Minimize total spending**
  - **Minimize budget overspending**
- ***MAXIMIZE MILITARY UTILITY FOR THE WAR FIGHTER***

IPP Overview



Integrated Investment Analysis (Prior to FY06 POM)

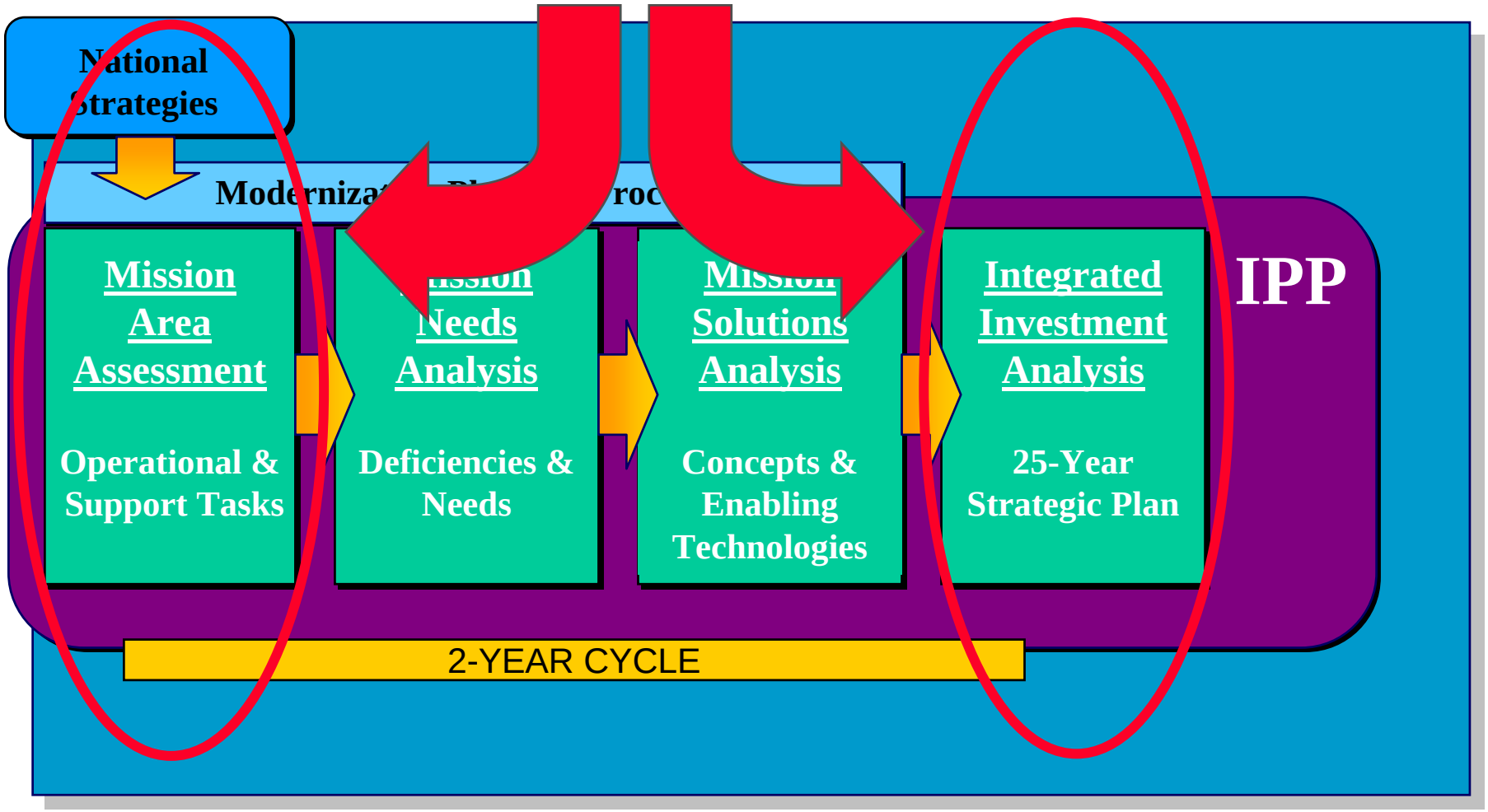


Problem Description

- **Prior to FY06 budget build, AFSPC relied solely on the Aerospace Integrated Investment Software (ASIIS - formerly SCOUT) to generate integrated architectures (family-of-systems) in Integrated Investment Analysis (IIA) phase**
- ***No true measure of military utility generated***
- **AFSPC IPP Pathfinder effort created to explore new analytical methods – starting with Counterspace mission area**

Revised IPP Analytical Focus

Process Focus Areas



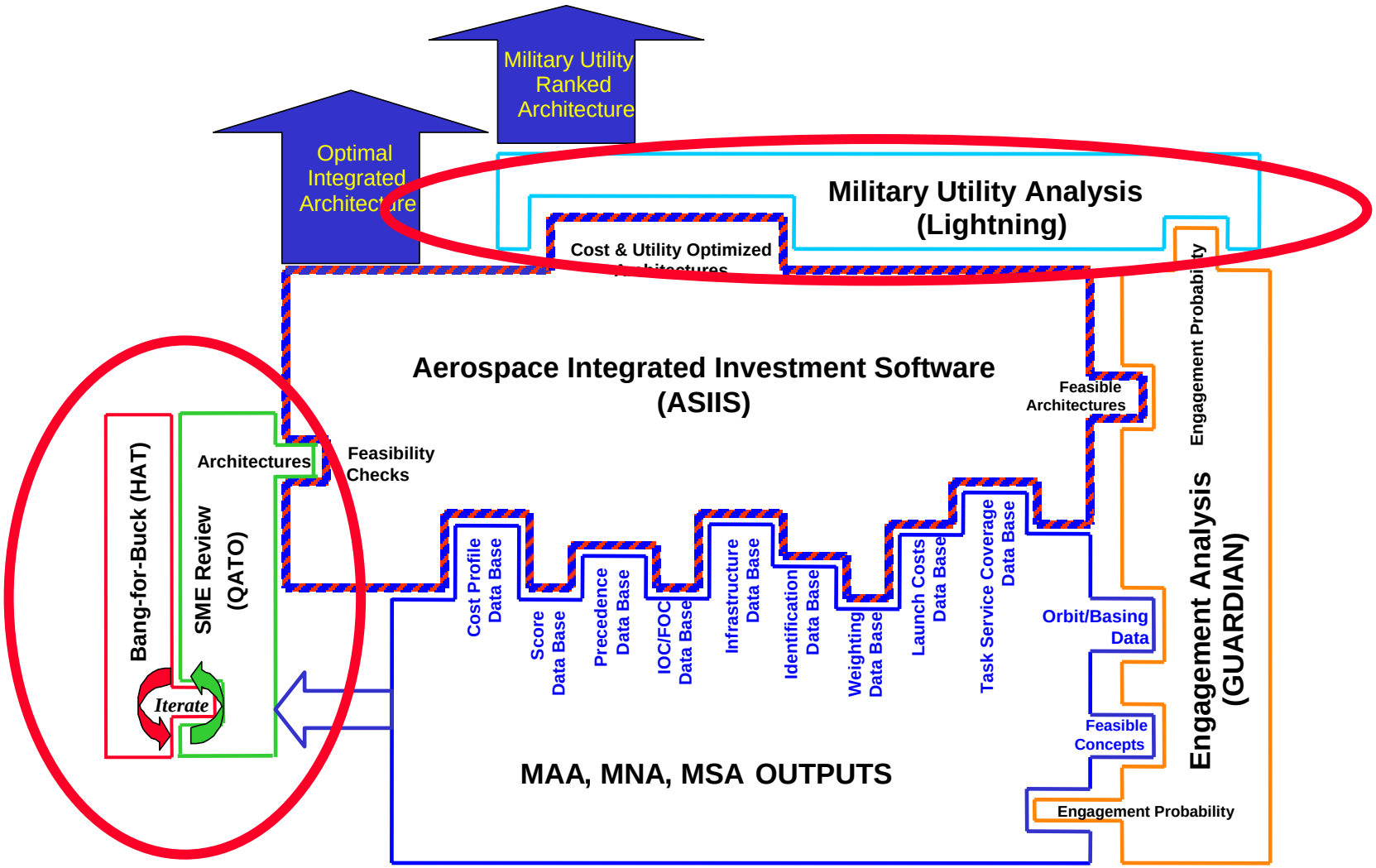
Mission Area Assessment (MAA) Analysis Description

- **Value hierarchy developed in Hierarchy Analysis Tool (HAT)**
- **MOEs/MOPs/Metrics defined**
- **Developed utility curves at MOP-level**
- **Weights for value hierarchy developed using Lightning campaign model**
  - **RT-2 Scenario**
  - **OCS weights derived directly from Lightning metrics (ISR, Comm, Nav, Wx)**
  - **DCS weights required translation from Lightning metrics to Threat systems (RF, KE, DE – High, DE – Low, CNA, Physical, HAND)**
- **Alternatives scored against MOPs**
- **Sensitivity analyses conducted**

Integrated Investment Analysis (IIA) Description

- **Candidate architectures identified in ASIIS**
- **Architectures run in the Quick Automated Tool for Optimization (QATO) to visually depict, modify, and conduct comparison of architectures by task effectiveness and cost**
- **QATO output modeled in the Hierarchy Analysis Tool (HAT) to assess military utility and provide architecture "bang-for-buck". HAT also provides recommended system changes to the architecture to improve performance based on Pareto optimality**
- **Changes iterated through QATO to ensure revised architecture meets budget/performance constraints**
- **Iterated architecture run in ASIIS to ensure feasibility**
- **Final architecture modeled in Lightning to provide military utility**

Revised Integrated Investment Analysis

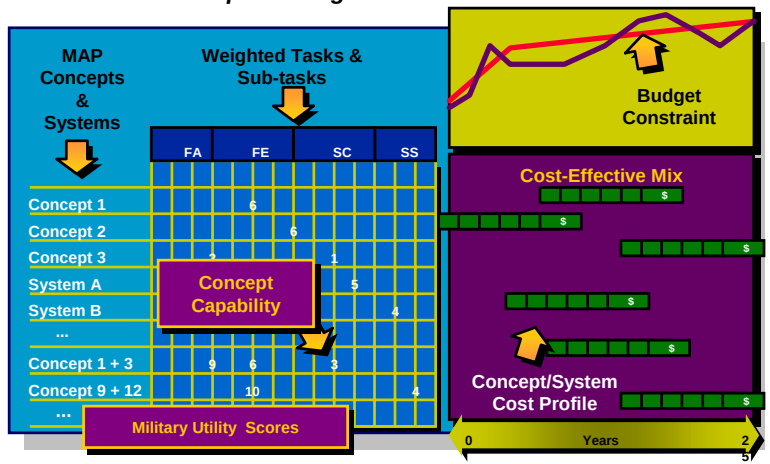


Analysis Tools

- **ASIIS**
- **QATO**
- **HAT**
- **Lightning**

ASIIS Description

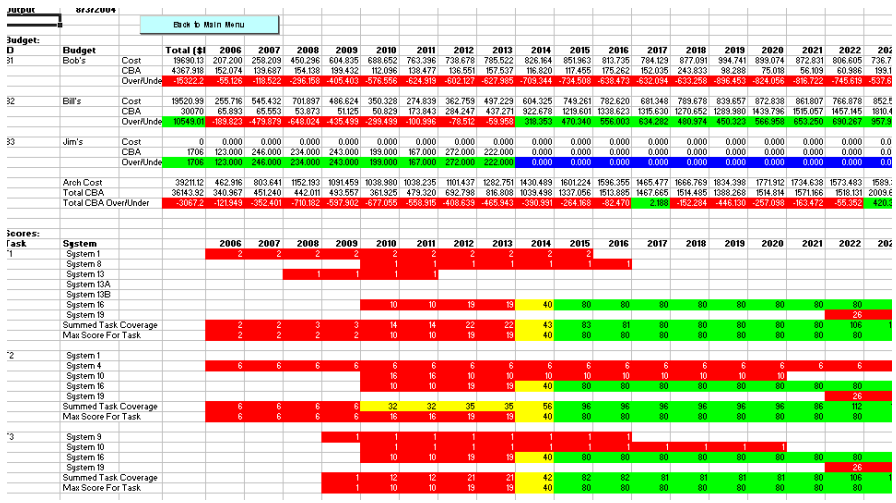
AeroSpace Integrated Investment Software



- **Budget constrained cost and utility optimizer**
- **Inputs:**
  - **System level engineering inputs**
  - **Cost information**
  - **Launch information (for space-based concepts)**
  - **Relationship and synergy information**
  - **Budget information**
- **Output is optimal set of systems based on Goal programming, Maximum Modeling Approach, and Mixed-Integer Linear Programming**
- **Optimal solution sets are input into QATO,HAT and LIGHTNING to compare system value against competing concepts and to determine military utility.**

QATO Description

- QATO is an Excel-based suite of tools developed to visually depict , modify, and conduct comparison of roadmaps by task effectiveness and cost
- QATO consists of three automated workbooks
  - QATO 2.2
  - QATO Compare
  - QATO Additional Calculations
- QATO provides a quick comparison of roadmaps by:
  - Task Effectiveness by year
  - Total Roadmap cost by fiscal year to budget authority
  - Roadmap cost by different budgets by fiscal year
- QATO provides the ability to modify a given roadmap
  - By turning systems on or off
  - Changing start/IOC/FOC/stop dates
  - By changing the budget authority
- QATO 2.2 can be used for POM support, AoAs, cut drills, and operational impact analyses



HAT Description

Applications

Reconnaissance: Developed a process & a recommended mix of airborne ISR capabilities

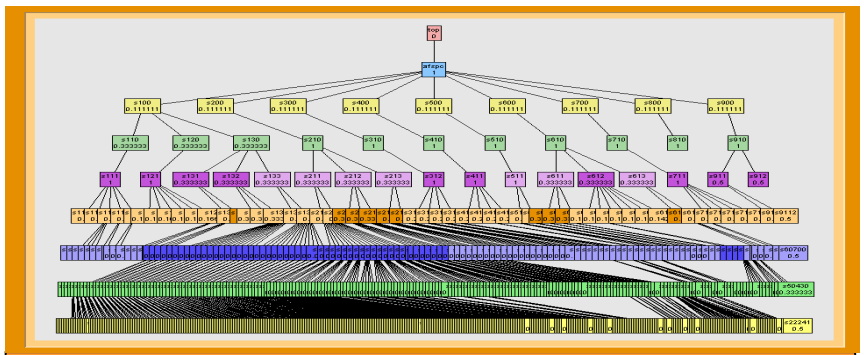
Source Selection Evaluation

- Selected best value combination of EO, SAR, & IR capabilities for $10B acquisition
- Identified “best” surface ship design & compelling rationale

Budget Allocation: Recommend a set of Programs & Initiatives responsive to diverse user needs within fiscal constraints

Analysis of Alternatives (AoAs)

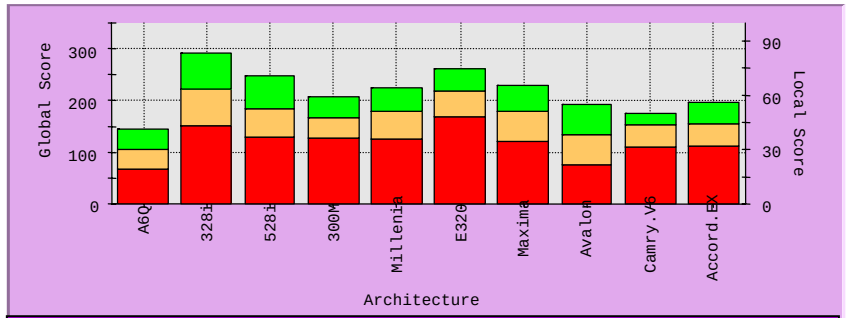
- Space Control
- Space Situational Awareness
- Operationally Responsive Spacelift (ORS)
- Future space architectures & initiatives



HAT allows visualization of value model at any & all levels

Runtime Environment

Required: Windows 2000/NT/98
Recommended: 500Mhz P3, 256MB Ram, 10+GB HD



HAT output shows detailed benefit data for selected architectures

Capabilities

Fast

- Runs in minutes on a standard PC
- Data input changes can be made within hours

Flexible

- Tailored to customer needs
- Evaluate leadership “what-ifs”

HAT output can show cost vs. benefit of all potential architectures

Lightning Description

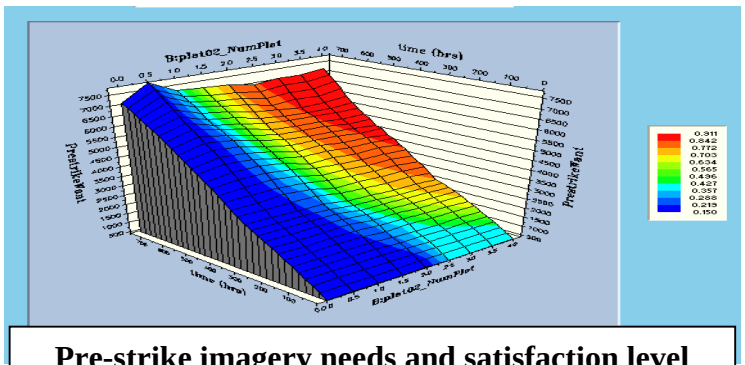
Capabilities

Fast
- 30-day campaign runs in a minute on a PC
- Run thousands of variations in a few days

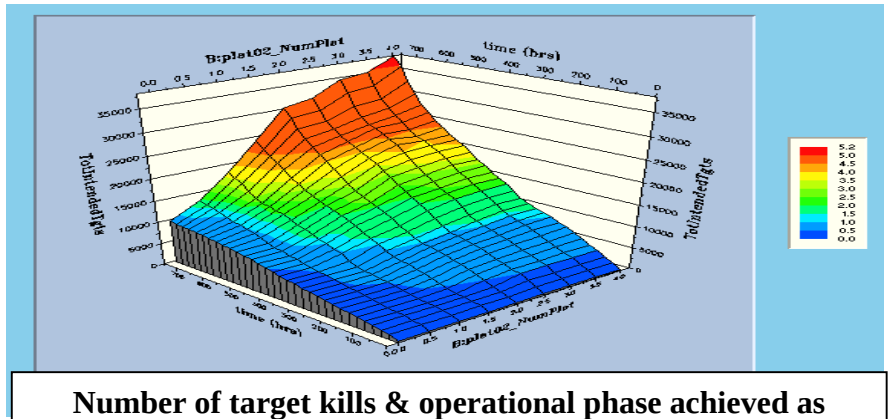
Flexible
- 30000+ potential experimental variables

Perception Model
- Truth & perceived states modeled via Battle-Space Awareness Matrix
- Known and unknown target identity
- Known and unknown target locations

Processes
- Air-to-Ground attacks
- Air-to-Air and Surface-to-Air attrition
- Reconnaissance & Surveillance
- Movement & Repair
- Linear program used to simulate daily ATOs based on perceived battle space state



Pre-strike imagery needs and satisfaction level



Number of target kills & operational phase achieved as functions of reconnaissance platforms over time

Applications

- Military utility of architectures and ops concepts
- Operational Impact of space system capabilities & Force-on-Force Studies
- Quick turnaround analyses using parametric sensitivity
- High dimensional full-factorial preview experiments to guide expensive high-fidelity model runs
- “What if” Experiments to determine sensitivity of battle outcomes to operational factors

Model Integration Process

- **Orbit/Basing data and concept feasibility from MAA, MNA and MSA analyses are fed into the GUARDIAN engagement analysis model**
- **Engagement probability is returned from Guardian for input into ASIIS and Lightning**
- **Additional MAA, MNA and MSA outputs are entered into ASIIS**
  - **Cost Profile**
  - **IOC/FOC**
  - **Task Service Coverage**
  - **Identification**
  - **Launch Costs**
  - **Precedence**
  - **Weighting**
  - **Infrastructure**
  - **Utility score**
- **ASIIS generates candidate architectures (family-of-systems)**

Model Integration Process (Continued)

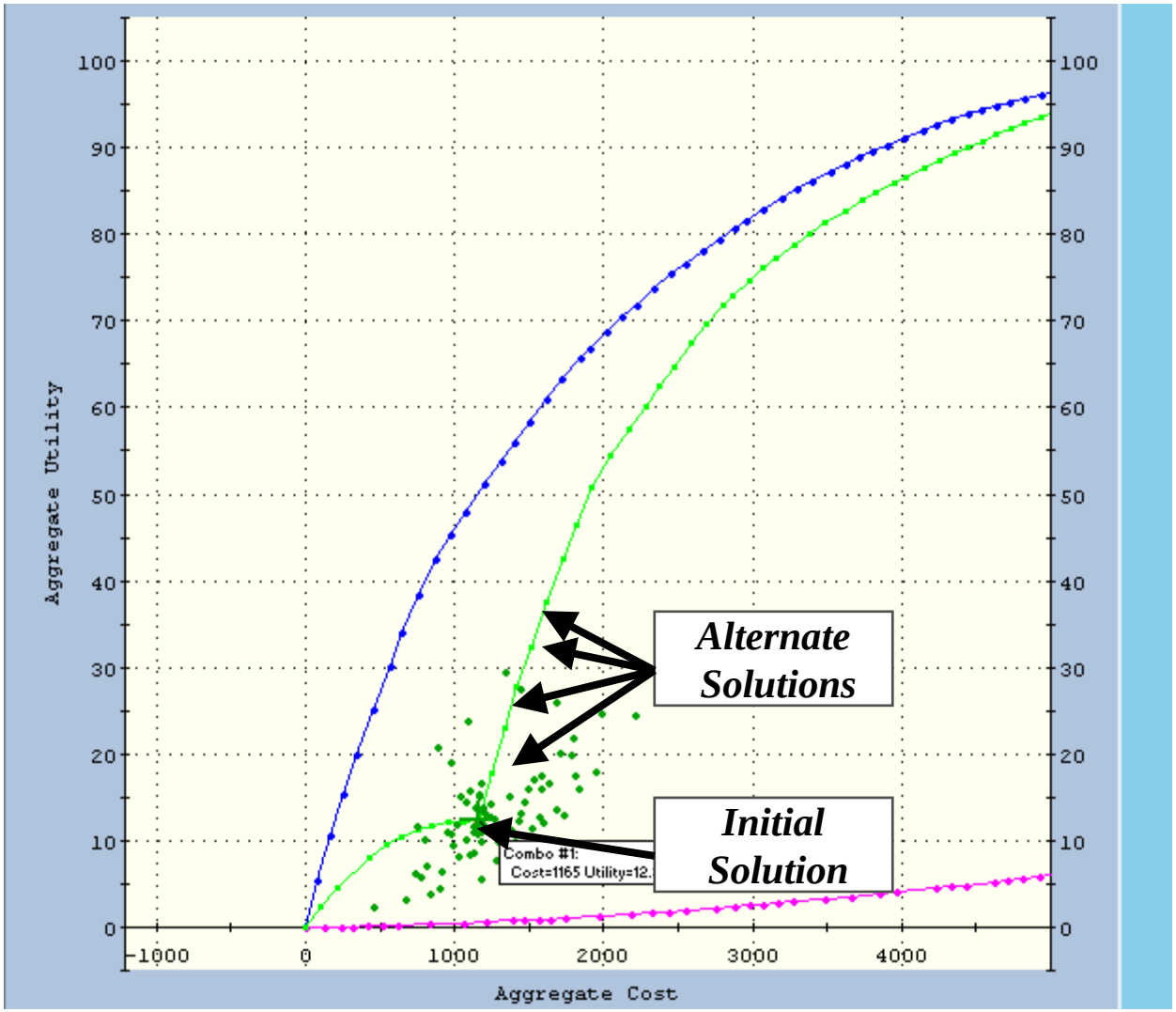
- **ASIIS-generated architectures are entered into QATO**
- **QATO provides the ability to modify a given roadmap**
  - **By turning systems on or off**
  - **Changing start/IOC/FOC/stop dates**
  - **By changing the budget authority**
- **QATO returns:**
  - **The different budgets, roadmap costs and an over/under budget comparison for each budget and total budget**
  - **Effectiveness score for the architecture, listed by task and each system that contributes to that task effectiveness along with a summed task effectiveness task row for that task**

Model Integration Process (Continued)

- **ASIIS-generated architectures are also entered into HAT**
- **HAT calculates "Bang-for-Buck" utility and generates a Pareto space to assess cost/benefit of each candidate architecture**
  - **Analysis of the Pareto space allows the analyst to recommend addition/removal of systems in the architecture to improve cost/benefit**
- **The refined architecture from the HAT model is returned to QATO to ensure the architecture meets budget/performance constraints**

Model Integration Process (Continued)

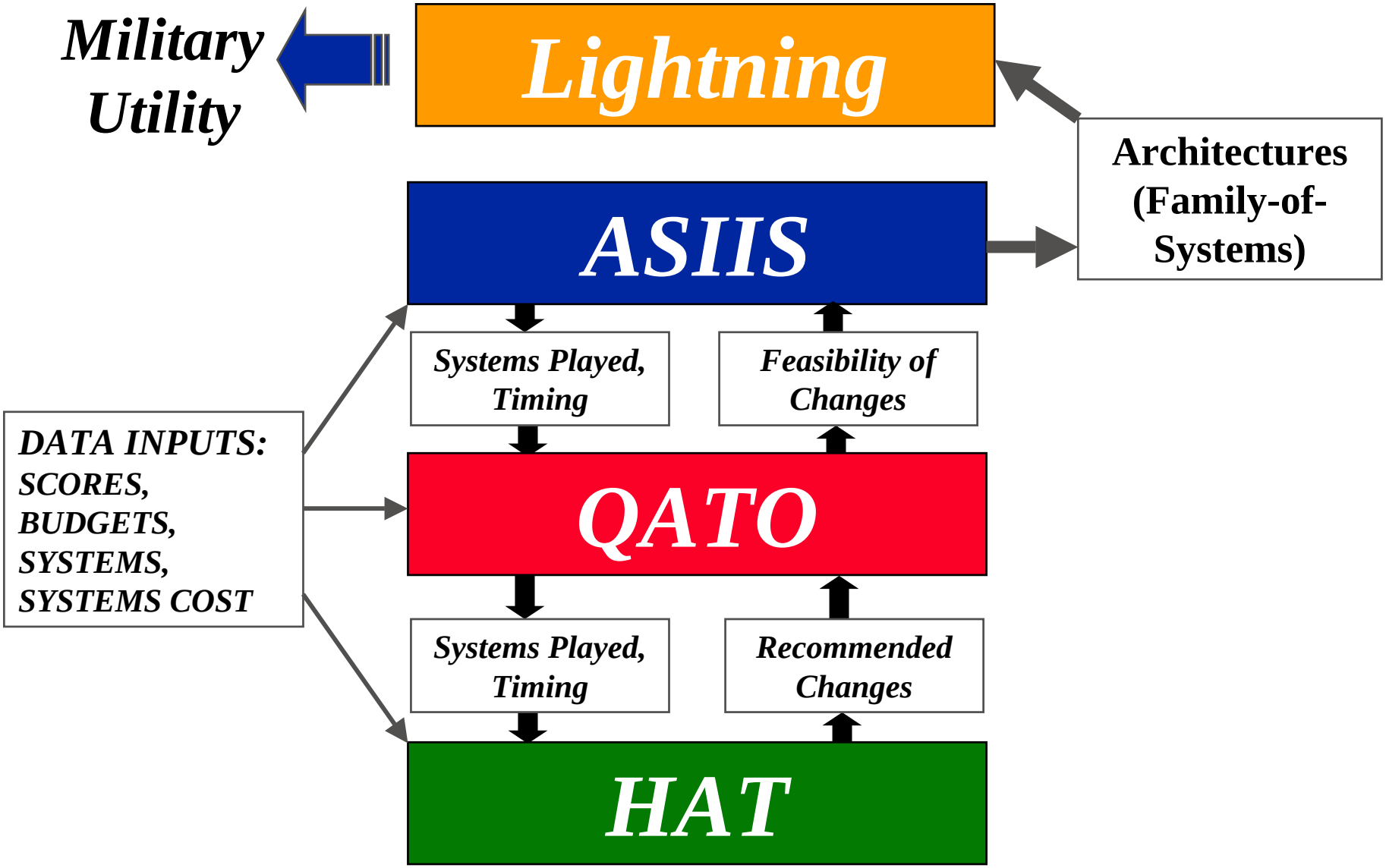
Pareto Space Analysis



Model Integration Process (Continued)

- **This QATO/HAT process is iterated until cost/benefit is maximized and the architecture meets fiscal constraints**
- **The revised architecture is then returned to ASIIS to ensure the architecture meets feasibility constraints**
- **This ASIIS/QATO/HAT cycle continues until an "optimal" solution is reached**
- **The finalized architecture is evaluated in the Lightning campaign model to provide a military utility analysis (MUA) assessment**

How the Tools Interact



Conclusion

- **Development of QATO**
- **Standardization/Integration of analytical models**
- **Process developed in pathfinder provided additional analytical rigor to traditional IPP**
- **Pathfinder analytical process resulted in more robust architectures**
- **New process provided additional sensitivity analysis**
- ***Military utility explicitly measured***

QUESTIONS?

Contact:

Danny Mellott	*(719) 622-5191*	*danny.mellott@ngc.com*
Joyce Stivers	*(719) 622-5240*	*joyce.stivers@ngc.com*
John Tindle	*(719) 622-5205*	*john.tindle@ngc.com*